

WHAT IS CLAIMED IS:

1. A failure diagnostic apparatus for a gas concentration detecting apparatus, comprising:
 - a heater which heats, to an activation temperature, a cell of the gas concentration detecting apparatus which pumps out oxygen in subject gas, thereby generating an electric current corresponding to a concentration of oxygen in the subject gas;
 - a flowing period detector which detects a period during which a predetermined electric current should flow in the cell after the heater starts heating; and
 - a determining device which determines that there is disconnection in the cell when the electric current flowing in the cell is smaller than the predetermined electric current during the period in which the predetermined electric current should flow in the cell.
2. The failure diagnostic apparatus according to claim 1, wherein the predetermined electric current is an initial electric current that is generated due to warming-up of the cell.
3. The failure diagnostic apparatus according to claim 2, wherein the gas concentration detecting apparatus includes a pump cell which pumps out, from a detection portion, oxygen contained in the subject gas flowing into the detection portion; and a sensor cell which decomposes NOx contained in the subject gas into nitrogen and oxygen after the pump cell pumps out oxygen, and further pumps out oxygen in the subject gas after decomposing of NOx contained in the subject gas into nitrogen and oxygen, and the cell determined the disconnection by the determining device is the sensor cell.
4. The failure diagnostic apparatus according to claim 2, wherein the gas concentration detecting apparatus includes a pump cell which pumps out, from a detection portion, oxygen contained in the subject gas flowing into the detection portion; a sensor cell which decomposes NOx contained in the subject gas into nitrogen and oxygen after the pump cell pumps out oxygen, and further pumps out oxygen in the subject gas after decomposing of NOx contained in the subject gas into nitrogen and oxygen; and a monitor cell which pumps out oxygen contained in the subject gas after the pump cell pumps out oxygen, and the cell determined the disconnection by the determining device is the monitor cell.
5. The failure diagnostic apparatus according to claim 2, wherein the flowing period

detector includes a counter which measures a time until a predetermined time elapses so that at least the beginning of a period during which the initial electric current should flow in the cell is reached after the heater starts heating.

6. The failure diagnostic apparatus according to claim 2, wherein the flowing period detector includes a resistance detector which detects an alternating current resistance value of the cell; and a resistance reduction detector which detects a reduction of the alternating current resistance value to a predetermined resistance value at which the initial electric current is generated.

7. The failure diagnostic apparatus according to claim 1, further comprising a prohibiting device which prohibits a determination on whether there is disconnection in the cell in a case where it is estimated that a temperature of the cell has already become high when the heater starts heating.

8. The failure diagnostic apparatus according to claim 1, wherein the cell includes a gas-side electrode which contacts the subject gas and an atmosphere-side electrode which contacts atmosphere; and the determining device includes a short-circuit detector which detects whether each of the gas-side electrode and the atmosphere-side electrode is short-circuited with a power source or a ground and determines whether there is disconnection in the cell is made only when neither the gas-side electrode or the atmosphere-side electrode is short-circuited with the power source or the ground.

9. A failure diagnostic method for a gas concentration detecting apparatus comprising the steps of:

heating, to an activation temperature, a cell of the gas concentration detecting apparatus which pumps out oxygen in subject gas, thereby generating an electric current corresponding to a concentration of oxygen in the subject gas;

detecting a period during which a predetermined electric current should flow in the cell after heating is started; and

determining that there is disconnection in the cell when the electric current flowing in the cell is smaller than the predetermined electric current during the period in which the predetermined electric current should flow in the cell.

10. The failure diagnostic method according to claim 9, wherein the predetermined electric current is an initial electric current which is generated due to warming-up of the cell.
11. The failure diagnostic method according to claim 10, wherein the gas concentration detecting apparatus includes a pump cell which pumps out, from a detection portion, oxygen contained in the subject gas flowing into the detection portion; and a sensor cell which decomposes NOx contained in the subject gas into nitrogen and oxygen after the pump cell pumps out oxygen, and further pumps out oxygen in the subject gas after decomposing of NOx contained in the subject gas into nitrogen and oxygen, and the cell determined the disconnection is the sensor cell.
12. The failure diagnostic method according to claim 10, wherein the gas concentration detecting apparatus includes a pump cell which pumps out, from a detection portion, oxygen contained in the subject gas flowing into the detection portion; a sensor cell which decomposes NOx contained in the subject gas into nitrogen and oxygen after the pump cell pumps out oxygen, and further pumps out oxygen in the subject gas after decomposing of NOx contained in the subject gas into nitrogen and oxygen; and a monitor cell which pumps out oxygen contained in the subject gas after the pump cell pumps out oxygen, and the cell determined the disconnection is the monitor cell.
13. The failure diagnostic method according to claim 10, wherein a time is measuring until a predetermined time elapses so that at least the beginning of a period during which the initial electric current should flow in the cell is reached after the heater starts heating when the period during which the predetermined electric current should flow in the cell is detected.
14. The failure diagnostic method according to claim 10, wherein an alternating current resistance value of the cell is detected; and a reduction of the alternating current resistance value to a predetermined resistance value at which the initial electric current is generated is detected when the period during which the predetermined electric current should flow in the cell is detected.
15. The failure diagnostic method according to claim 9, wherein a determination whether

there is on disconnection in the cell is prohibited in a case where it is estimated that a temperature of the cell has already become high when the heater starts heating.

16. The failure diagnostic method according to claim 9, wherein the cell includes a gas-side electrode which contacts the subject gas and an atmosphere-side electrode which contacts atmosphere; it is detected whether each of the gas-side electrode and the atmosphere-side electrode is short-circuited with a power source or a ground when a determination on whether there is disconnection in the cell is made; and the determination on whether there is disconnection in the cell is made only when neither the gas-side electrode or the atmosphere-side electrode is short-circuited with the power source or the ground.